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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Erwin KRIMMER, et al

Based on PCT/DE 01/02222

For: ACTUATOR, IN PARTICULAR FOR VALVES, RELAYS OR THE LIKE

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE SPECIFICATION

Page 1, Between the title and paragraph [0001] insert the following:

[0000.2] CROSS-REFERENCE TO RELATED APPLICATIONS

[0000.4] This application is a 35 U.S.C. 371 application of PCT/DE 01/02222, filed on June 19, 2001.

[0000.6] BACKGROUND OF THE INVENTION

Replace paragraph [0001] with the following rewritten paragraph:

[0001] Field Of The Invention

Replace paragraph [0002] with the following rewritten paragraph:

[0002] The invention is based on an actuator, in particular for valves, relays, or the like.

Between paragraphs [0002] and [0003] insert the following:

[0002.5] Description Of The Prior Art

Replace paragraph [0004] with the following rewritten paragraph:

[0004] SUMMARY OF THE INVENTION

Replace paragraph [0005] with the following rewritten paragraph:

[0005] The actuator according to the invention has the advantage that it is bistable and the magnet armature always remains in one of the two end positions until it is transferred into the other end position through a temporary supply of current to the magnet coil and then remains there without being supplied with energy from the outside. Energy is only required to transfer the magnet armature into one of the two end positions and the energy is largely converted into mechanical work. The magnet armature is held in the end position itself by means of the mechanical locking device, which is preferably embodied as an over center or snap switch mechanism or as a detent locking mechanism, without the supply of energy so that the power loss and the heating of the actuator and control unit are eliminated. The control unit driver stages for supplying current to the magnet coil therefore does not have to be designed for continuous operation, but only for the short power supply pulses that are used to transfer the magnet armature from the one end position to the other. This cuts down on the installation space occupied and the costs incurred by the components in the electrical circuit.

Page 2, delete paragraph [0007]:

Page 4, Replace paragraph [0012] with the following rewritten paragraph:

[0012] BRIEF DESCRIPTION OF THE DRAWINGS

Page 5, Replace paragraph [0020] with the following rewritten paragraph:

[0020] DESCRIPTION OF THE PREFERRED EMBODIMENTS

Page 6, Replace paragraph [0022] with the following rewritten paragraph:

[0022] The magnet coil 11 is wound on a hollow cylindrical coil body 16 similar to a yarn spool, which is bounded on the ends by two annular flanges 161. The magnet yoke 13 is U-shaped and has two yoke legs 132, 133, which extend parallel to each other and are connected to each other by means of a yoke bridge 131. The magnet yoke 13 embraces the coil body 16 with the wound magnet coil 11 between the yoke legs 132, 133 so that the coil axis is aligned with the normals of two insertion openings 17, 18 let into the two yoke legs 132, 133. The magnet armature 12 is guided so that it can move axially inside the hollow cylindrical coil body 16 and is matched to the magnet yoke 13 in length so that in each end position of the magnet armature 12, one of the armature ends 121 or 122 is inserted maximally into one of the insertion openings 17, 18, while the other is inserted minimally into the other insertion opening. The maximal insertion depth of the armature ends 121, 122 is dimensioned as slightly greater than the thickness of the yoke legs 132, 133 measured in the axial direction of the magnet armature. In this manner, the magnet armature 12 has a stable middle position, also referred to as the equilibrium position of the electromagnet 10, which is

disposed in the middle between the two end positions and can be approached from the two end positions by supplying the magnet coil 11 with current.

Replace paragraph [0023] with the following rewritten paragraph:

[0023] In the depiction in Fig. 2, the magnet armature 12 is inserted with its left armature end 121 maximally into the insertion opening 17 in the magnet yoke 13 and is inserted with its right armature end 122 minimally into the insertion opening 18 in the magnet yoke 13. This end position of the magnet armature 12 is labeled E_L in the characteristic curve depicted in Fig. 5. The characteristic curve in Fig. 5 demonstrates on the one hand the function of the magnetic force F over the sliding path s of the magnet armature 12 and on the other hand, demonstrates the function of the voltage pulse applied to the magnet coil 11 over the sliding path of the magnet armature 12. In the above-mentioned stable left end position E_L of the magnet armature 12, it is fixed by the locking device 15 without energy being supplied to the magnet coil 11.

Page 9, Replace paragraph [0026] with the following rewritten paragraph:

[0026] In the modified electromagnetic actuator shown in the detail in Fig. 6, the locking mechanism 15 for currentless fixing of the magnet armature 12 it its two stable end positions is embodied as a detent locking mechanism 21. In an extremely simple fashion, a detent locking mechanism 21 of this kind is comprised of a spring-loaded detent element 22, which engages in a detent recess or detent groove 23 in the actuation tappet 14 in each end position of the magnet armature 12. The two detent grooves 23 are disposed in the actuation tappet 14 spaced apart from each other by an axial distance that corresponds to the stroke h of the magnet armature 12. The

detent element 22, which is embodied here as a detent sphere, is guided in a spatially fixed sleeve 24, which is aligned at right angles to the actuation tappet 14 and contains a detent spring 25. The detent spring 25 is supported at one end against the detent sphere or the detent element 22 and is supported at the other end against the sleeve bottom and pushes the detent element 22 into the respective detent groove 23. The two detent grooves 23 have lifting bevels 231 so that when the actuation tappet 14 is slid, the detent element 22 can be lifted out of the detent groove 23.

Page 11, After paragraph [0035] insert the following new paragraph:

[0036] The foregoing relates to preferred exemplary embodiments of the invention, it being understood that other variants and embodiments are possible within the spirit and scope of the invention, the latter being defined by the appended claims.

Page 12, Line 1, delete “Claims” and insert --“We Claim”--.

IN THE CLAIMS

Please cancel claims 1-17 and add new claims 18-37.

18. An actuator, in particular for valves, relays, or the like, comprising an electromagnet (10) including a magnet coil (11), a magnet armature (12) moveable between two end positions, and a magnet yoke (13),

an actuation tappet (14) driven by the magnet armature (12),

the magnet armature (12) having a stable middle position disposed between the two end positions and which can be approached from the two end positions by supplying current to the magnet coil (11), and

at least one bistable mechanical locking mechanism (15), which comes into play in the end positions, acts on the magnet armature (12) or on the actuation tappet (14).

19. The actuator according to claim 18 wherein the magnet armature (12) is inserted with its two armature ends (121, 122) through mutually aligned insertion openings (17, 18) in the magnet yoke (13) and that the length of the magnet armature (12) and the embodiment of the magnet yoke (13) are matched to each other so that in each end position of the magnet armature (12), one of the armature ends is inserted maximally into the associated insertion opening (17, 18) in the magnet yoke (13) and the other is inserted minimally into the associated insertion opening (17, 18).

20. The actuator according to claim 19 wherein the magnet yoke (13) is U-shaped, with two yoke legs (132, 133) connected by means of a yoke bridge (131) and that the two insertion openings (17, 18) for the armature ends (121, 122) of the magnet armature (12) are disposed in the opposing yoke legs (132, 133).

21. The actuator according to claim20 wherein the magnet coil (11) is wound onto a hollow cylindrical coil body (16), which is embraced between the yoke legs (132, 133) of the magnet yoke (13) so that the coil axis is aligned with the normals of the insertion openings (17, 18), and in that the magnet armature (12) is guided so that it can move axially in the coil body (16).

22. The actuator according to claim 20 wherein the maximal insertion depth of the armature ends (121, 122) is slightly greater than the width of the yoke legs (132, 133) extending in the axial direction of the magnet armature (12).

23. The actuator according to claim 21 wherein the maximal insertion depth of the armature ends (121, 122) is slightly greater than the width of the yoke legs (132, 133) extending in the axial direction of the magnet armature (12).

24. The actuator according to claim 18 wherein the magnet coil (11) is supplied with current by means of current pulses, whose duration is determined so that with the end of one current pulse, the magnet armature (12) being moved out of its end position has approximately reached its middle position and the energy stored in the magnet armature (12) is sufficient to drive the magnet armature (12) past the middle position, into its other end position.

25. The actuator according to claim 22 wherein the magnet coil (11) is supplied with current by means of current pulses, whose duration is determined so that with the end of one current pulse, the magnet armature (12) being moved out of its end position has approximately reached its middle position and the energy stored in the magnet armature (12) is sufficient to drive the magnet armature (12) past the middle position, into its other end position.

26. The actuator according to claim 18 wherein the locking mechanism (15) is embodied as a detent locking mechanism (21).

27. The actuator according to claim 18 wherein the locking mechanism (15) is embodied as a snap switch mechanism (26), which after a slack point position is passed, exerts a drive force on the magnet armature (12) or actuation tappet (14).

28. The actuator according to claim 27 wherein the snap switch mechanism is embodied as a split spring washer (19).

29. The actuator according to claim 18 comprising two bistable locking mechanisms (15).

30. The actuator according to claim 18 further comprising at least one guide element (50) whereby the magnet armature (12) is guided by the at least one guide element (50) and the locking mechanism (15).

31. The actuator according to claim 29 further comprising at least one guide element (50) whereby the magnet armature (12) is guided by the at least one guide element (50) and the locking mechanism (15).

32. The actuator according to claim 18 wherein the actuator (1) has two locking mechanisms (15) and that the magnet armature (12) is guided by the locking mechanisms (15).

33. The actuator according to claim 18 wherein the actuation tappet (14) includes a valve plate (55), which opens or closes an opening (57) in a housing (59).

34. The actuator according to claim 18 wherein the actuator (1) is part of a tank ventilation system.

35. The actuator according to claim 18 wherein the locking mechanism (15) is a leaf spring (19).

36. The actuator according to claim 35 wherein the leaf spring (19) has at least one spring element (52).

37. The actuator according to claim 35 wherein the leaf spring (19) is comprised of two mirror-inverted S sections connected to each other.

IN THE ABSTRACT

Please substitute the attached Abstract of the Disclosure for the abstract as originally filed.

REMARKS

The above amendments are being made to place the application in better condition for examination.

Entry of the amendment is respectfully solicited.

Respectfully submitted,

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ABSTRACT OF THE DISCLOSURE

An actuator, in particular for valves, relays, or the like, is disclosed, which has an electromagnet with a magnet coil, a magnet armature that can be slid between two end positions, and a magnet yoke, and has an actuation tappet driven by the magnet armature. In order to produce a bistable actuator with a low power consumption and a low heating of current-carrying components – particularly when long switching times in both switch positions are required, on the one hand, the electromagnet is embodied so that its magnet armature has a stable middle position that is disposed between its two end positions, which are determined by the two switch positions of the actuator, and that can be approached from both end positions by supplying current to the magnet coil, and on the other hand, a bistable mechanical locking mechanism is provided, which acts on the magnet armature or on the actuation tappet and comes into play in the end positions of the magnet armature.

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

Page 1, Paragraph [0001] has been amended as follows:

[0001] ~~Prior Art~~ Field Of The Invention

Paragraph [0002] has been amended as follows:

[0002] The invention is based on an actuator, in particular for valves, relays, or the like~~, as generically defined by the preamble to claim 1~~.

Paragraph [0004] has been amended as follows:

[0004] ~~Advantages of the Invention~~ SUMMARY OF THE INVENTION

Paragraph [0005] has been amended as follows:

[0005] The actuator according to the invention~~, with the features of claim 1,~~ has the advantage that it is bistable and the magnet armature always remains in one of the two end positions until it is transferred into the other end position through a temporary supply of current to the magnet coil and then remains there without being supplied with energy from the outside. Energy is only required to transfer the magnet armature into one of the two end positions and the energy is largely converted into mechanical work. The magnet armature is held in the end position itself by means of the mechanical locking device, which is preferably embodied as ~~a~~ an over center or snap switch mechanism or as a detent locking mechanism, without the supply of energy so that the power loss and the heating of the actuator and control unit are eliminated. The control unit driver stages for supplying current to the magnet coil therefore does not have to be designed for continuous operation, but only for the short power supply pulses that are used to transfer the magnet armature from the one end position to the other. This cuts down on the installation space occupied and the costs incurred by the components in the electrical circuit.

Page 4, Paragraph [0012] has been amended as follows:

[0012] ~~Drawings~~ BRIEF DESCRIPTION OF THE DRAWINGS

Page 5, Paragraph [0020] has been amended as follows:

[0020] ~~Description of the Exemplary Embodiments~~ DESCRIPTION OF THE PREFERRED EMBODIMENTS

Page 6, Paragraph [0022] has been amended as follows:

[0022] The magnet coil 11 is wound on a hollow cylindrical coil body 16 similar to a yarn spool, which is bounded on the ends by two annular flanges 161. The magnet yoke 13 is U-shaped and has two yoke legs 132, 133, which extend parallel to each other and are connected to each other by means of a yoke bridge 131. The magnet yoke 13 embraces the coil body 16 with the wound magnet coil 11 between the yoke legs 132, 133 so that the coil axis is aligned with the normals of two insertion openings 17, 18 let into the two yoke legs 132, 133. The magnet armature 12 is guided so that it can move axially inside the hollow cylindrical coil body 16 and is matched to the magnet yoke 13 in length so that in each end position of the magnet armature 12, one of the armature ends 121 or 122 is inserted maximally into one of the insertion openings 17, 18, while the other is inserted minimally into the other insertion opening. The maximal insertion depth of the armature ends 121, 122 is dimensioned as slightly greater than the thickness of the yoke legs 132, 133 measured in the axial direction of the magnet armature. In this manner, the magnet armature 12 has a stable middle

position, also referred to as the equilibrium position of the electromagnet 10, which is disposed in the middle between the two end positions and can be approached from the two end positions by supplying the magnet coil 11 with current.

Paragraph [0023] has been amended as follows:

[0023] In the depiction in Fig. 2, the magnet armature 12 is inserted with its left armature end 121 maximally into the insertion opening 17 in the magnet yoke 13 and is inserted with its right armature end 122 minimally into the insertion opening 18 in the magnet yoke 13. This end position of the magnet armature 12 is labeled E_L in the characteristic curve depicted in Fig. 5. The characteristic curve in Fig. 5 demonstrates on the one hand the function of the magnetic force F over the sliding path s of the magnet armature 12 and on the other hand, demonstrates the function of the voltage pulse applied to the magnet coil 11 over the sliding path of the magnet armature 12. In the above-mentioned stable left end position E_L of the magnet armature ~~11~~ 12, it is fixed by the locking device 15 without energy being supplied to the magnet coil 11.

Page 9, Paragraph [0026] has been amended as follows:

[0026] In the modified electromagnetic actuator shown in the detail in Fig. 6, the locking mechanism 15 for currentless fixing of the magnet armature 12 it its two stable end positions is embodied as a detent locking mechanism 21. In an extremely simple fashion, a detent locking mechanism 21 of this kind is comprised of a spring-loaded detent element 22, which engages in a detent recess or detent groove 23 in the actuation tappet 14 in each end position of the magnet armature 12. The two detent grooves 23 are disposed in the actuation tappet 14 spaced apart from each other by

an axial distance ~~the~~ that corresponds to the stroke h of the magnet armature 12. The detent element 22, which is embodied here as a detent sphere, is guided in a spatially fixed sleeve 24, which is aligned at right angles to the actuation tappet 14 and contains a detent spring 25. The detent spring 25 is supported at one end against the detent sphere or the detent element 22 and is supported at the other end against the sleeve bottom and pushes the detent element 22 into the respective detent groove 23. The two detent grooves 23 have lifting bevels 231 so that when the actuation tappet 14 is slid, the detent element 22 can be lifted out of the detent groove 23.